PART I

PRODUCTION, PLANNING AND CONTROL

1

Production, Planning and Control

1.1. INTRODUCTION

Any manufacturing activity requires resource input in terms of men, materials, capital and machines. In any business that produces a product or service, production activity must be related to market demands as indicated by the continuous stream of customer's orders. For maximum effectiveness, this must be done in such a way that customer demands are satisfied, but at the same time production activities are carried on in an economic manner. The process of developing this kind of relationship between market demands and production capability is the function of production planning and control or sometimes referred to as production control.

Production planning and control can be effected principally through the management of work flow, inventories and backlogs and changing levels of operation. The set of policies and procedures that are used to manage work flow, inventories backlogs and changes in the level of production rate comprise, what is called a production planning and control system.

No one can say when man first studied production. Even in the ancient times, attention was given to management methods, in the conduct of Government, Organisation, for construction and other work where co-operative endeavour was required.

In industry methods of organising, planning, supervising and controlling the flow of production were developed at least as early as the days of Adam Smith writing in 1776, he described the process of making ordinary brass pins. He makes a distinction between the production line worker, the person who designs the machine and handles other engineering problems, and the manager who plan, organise, supervise, observe, and control the operation. These distinctions are basic to much of modem management.

Beginning of Work Measurement. Studies in work measurement were made from time to time in both the USA and UK. Some of these studies included the use of stopwatch. An interesting study of this nature was made by Thomas Jefferson in 1769 as he began to dig the foundation of new home near Charlottesville, Virginia. He estimated the amount of dirt that one person could dig and haul away in a day of 12 hours. Standards of this kind constituted the essential feature of the Taylor system of management which was developed later.

Standardisation of Product. Another early development was the production of parts according to specifications in such manner that the parts were interchangeable. Eli Whitney is credited with having developed the principle of interchangeable parts in the manufacture of muskets.

Development of Manufacturing Methods. In the beginning of about 1775 a number of machines were developed for the manufacture of cloth, which was one of the most important industries. The changes in methods of production soon extended to other industries with the invention of the steam engine, the cotton gin, the steam boat, the reaper and other machines. These inventions not only revolutionised methods of production on farms and in factories that

used the machine but also gave rise to new industries for the manufacture of machines and machine parts used in their production.

With the introduction of new machines larger factories were built to employ larger number of people. The work of production was further sub-divided into smaller tasks to provide for greater specialisation among the workers. Attention was directed to such problems as plant location, plant layout, methods of moving materials and the design of factory buildings, machines were gradually improved and new machines were invented from time to time.

Development of Management Methods. During the first half of the nineteenth century attention began to be directed towards such management problems as personnel relations, hours of work, fatigue and market relationships.

Scientific Management. Scientific management is the name given to a new movement which began in a small way in the later part of the nineteenth century and received national prominence in the first two decades of the present century. The new system was characterised by a spirit of inquiry, the questioning of all conventional management, methods and technique and an attempt to promulgate basic management principles. Probably the best known of these persons associated with the new movement were F.W. Taylor, H.L. Gantt, Frank B.L.M. Gilbreth.

Taylor's work was in tune with the vaunted reputation of contemporary scientific investigations and, therefore, he lodged his concepts under the title of scientific management. His theories received both acclaim and abuse. Critics forecasted that his mechanistic views enforced by efficiency experts would completely de-humanise industry but others saw them as logic applied to a promising new area. Whether people agreed with him or not, his beliefs and the fervor with which he expounded them, strongly stimulated industrial management.

An associate of Taylor, Henry L. Gantt, developed methods of sequencing production activities which are still in use today.

Operations-oriented thinking took new substance from the literal as well as figurative marriage of engineering and psychology in the husband-wife team of Frank and Lillon Gilbreth, the mechanistic attitudes of engineer Frank were mitigated by the humanistic attitudes of psychologist Lillain. Together they showed that basic human motion patterns are common to many different work situations. Their analysis of micromotions to improve manual operations initiated time and motion studies and the use of motion pictures in work design.

In the 1920's and 1930's things become more complicated as it was realised that people did not always behave as intuitively expected and that the complicities of emerging production processes required more controls. As demonstrated by the famous Hawthrone studies, the carrot of better wages or working conditions did not always lead to proportional increase in output, psychological factors such as morale and attention were influential.

An interdisciplinary approach to system studies appeared in the war years of 1940's first in the form of British operational research teams.

The 1940's also saw the birth of the electronic computer. Today its influence is apparent throughout industry. Equivalently, The capabilities of computers must be utilised if we expect to relate and evaluate the many variables in complex production systems.

1.2. INDIAN INDUSTRIAL SCENARIO AND PPC

India's developing economy needs PPC. The importance of PPC cannot be over emphasised, particularly under the present circumstances of India. We are undergoing an era of planning. The main intension behind industrial planning is to accelerate the productivity so that our goods may find a suitable market abroad. But the need for greater, better and cheaper

goods is out of question without proper planning and adequate control. A successful production control programme minimises the idleness of the men and machines optimizes the number of setups required, keeps in process inventories at a satisfactory level, reduces material handling and storage costs and consequently permits quantity and quality at low unit costs.

PPC is factory's nervous system. The functions of PPC in a factory can easily be compared with the nervous system in human organism. It serves to co-ordinate the activities of a plant just as the nervous system regulates muscular movements. When simple repetitive operations are performed, production control or accomplished more is less subconsciously in the same manner that the nervous system automatically regulates one's breathing. When less repetitive activity is involved, more conscious direction is necessary, both in the plant and in the human system.

Customer demands are likely to differ in quantities and delivery schedules and this will lead to large fluctuations in the production levels. So to meet any demand, it is desirable to have planning for production in future time periods for inventories of finished goods and meet part of market demands from such finished goods inventories. Furthermore, the lead times involved in procurement of manufacturing imputs warrant planning for production in advance. This is particularly so, in the Indian context, with specific reference to industrial raw materials. Also, requirements of skilled manpower necessitate such planning where time factor involved in training personnel is rather large. Also the socio-political structure in India makes it quite difficult for an organisation to have varying manpower levels. This, again, necessitates production planning in order to smooth out the needs for manpower.

Another reason why PPC is necessary, is the need to meet changes in demands due to trend, cyclical and reasonal factors. Long-run changes in demand are taken care of by change in overall capacity by expansion and or new facilities. However, in short run, these will have to be taken care of by such factors as sub-contracting, using overtime and building up inventories. Needless to say, in planning production for these purposes, one should take into consideration the changes in production levels over future periods in order to economise the cost of production. This is an important factor which necessitates planning for production and exercising control.

Moreover, production operations are subject to variety of uncertainties such as emergency order, breakdown, material shortages and various other contingencies. PPC provides a way to take these factors into considerations.

1.3. ADVANTAGES AND LIMITATION OF PPC

1.3.1 PPC can infulence Enterprise Operational Performance in Two Factors

(*i*) Material factors.

(*ii*) Human factors.

(*a*) **Material factors.** Under this following categories are included:

(*i*) *Quality of the output.* An improvement in volume of output within quality and safety limits laid down by management is most common objective of PPC.

(*ii*) *Plant utilisation.* With ever increasing capital investment per producer in industry, making fuller use of plant is of growing importance. Experience and research has shown that in many types of plant the capital saving due to improved load factors are proving the most substantial of all. These improvements are also being achieved through better labour effectiveness.

(*iii*) *Use of services.* Again economic in the use of steam, water, air and electricity may be paramount factors.

(*iv*) *Quality of product.* It may be sometimes desirable for economic or other reasons, to improve the quality of product new or more consistant standard.

(*v*) *Process efficiency.* An operator can have a far more significant effect on process efficiency than was previously envisaged.

(*vi*) *Standard of safety.* In dealing with many products quite apart from the normal good standards a particularly high level of safety may be important, which is being achieved by it.

(*vii*) *Works cleanliness.* It is another objective of management.

(*b*) **Human factors.** Under this heading following may be included:

(*i*) *Effectiveness of work.* The work should be such that it meets the ego and emotion of the worker and he feels the pride over it. In other words, the objective of management is to choose right man for right job at right place at right time on right wages and salaries.

(*ii*) *Interest in work.* The worker should take interest in work and he will put the heart and hand in performing the task is another prime aim of good management.

(*iii*) *Waiting time.* The waiting time should remain minimum for the want of material, tools, equipment, supervision, inspection, delivery, etc. It can only be achieved when the worker on the work will help fully and take interest in it.

(*iv*) *Need for supervision.* To make the worker expert and self-dependent in normal day to day work is the other aim of the management. The supervisory time should be reduced. The supervisors should be left to perform the task of planning, coordination, motivation, control and feedback informations only.

(*v*) *Ideas for new methods.* Workers, working on the machine are said to be the best man for new idea and suggestions, as he knows the various aspect of work fully. To give encouragement to the worker for new ideas and new method the PPC is brought in picture.

(*vi*) *Team spirit.* To develop the team spirit and feeling of brotherhoodness among workers is another aim. The workers should do the work as a team, and should recognise their value and status in company as a group not individuals.

(*vii*) *Absenteeism.* To minimise and regulate the absenteeism, PPC may be introduced.

(*viii*) *Labour turnover.* It helgs the turnover to its minimum.

1.3.2. Advantages PPC

The advantages of PPC can be viewed from company point of view, share holders point of view, employees' point of view and society point of view. A brief outline of advantage is listed below from all the angles:

From Company's point of view. The main advantages is, cost of product per piece reduces, and the company enjoys better and more earnings. The administration and management task go, ahead smoothly and efficiently. How this is achieved is briefly outlined under following captions:

1. Production Management aspect. This is one of the most essential field which helps in reducing cost per unit of production. This caption is further sub-divided as follows:

(*i*) *Production control*:

(*a*) It facilitates in receipts, shipment and delivery.

(*b*) It paces production.

(*c*) It reduces conflict among workers.

(*d*) It helps in production time predictable.

(*e*) It helps in scheduling and dispatching automatically.

(*f*) If helps in setting up production centres.

(*g*) It reduces the number of parts and their cost and helps in mismatched part.
(*h*) Reduces the numbers of stock chasers.
(*i*) Reduces the production control expenses.
(*ii*) *Quality Control and Waste Reduction.* PPC helps in:
(*a*) Maintaining the rigid quality control.
(*b*) Minimising the wastes, scrap and rework.
(*c*) Minimising the rectification hours.
(*d*) Cost of inspection is reduced.
(*e*) Reduction of variations in manufactured goods.
(*iii*) *Advantages in the manufacturing Costs.* These can be briefed as follows:
(*a*) Decreased maintenance cost.
(*b*) Decreased tool replacement.
(*c*) Effects a saving in power load.
(*d*) Decrease in spoilage and scrap.
(*e*) Reduced raw material wastage.
(*f*) Better cost control.
(*g*) Reduced handling helps in saving time and quality.
(*iv*) *Advantages to Labour Cost.* These are as follows:
(*a*) Increased output per man hour.
(*b*) It helps in reducing set up time.
(*c*) Reduced number of operation.
(*d*) Reduced number of handling.
(*e*) Reduced length of handling.
(*f*) Reduced labour waiting time.
(*v*) *Advantage to Management and Organisation:*
(*a*) It helps in adopting better, efficient and effective planning.
(*b*) Better feed back and effective control system can be installed in different spheres of activities.
(*c*) It helps on coordination and synchronising, the employee's efforts towards the same goal as of the management.
(*d*) Reduced conflicts with trade unions and hence reduced and eliminated strikes and lock-out.
(*e*) Reduced absenteeism, turn over and accidents.
(*f*) The management can efficiently and effectively install and develop the new techniques of production and automation, if any
(*g*) Improved and better human relations.
(*h*) Higher morale among workers which leads to better cooperation, helping attitude and up attitude of team spirit.
(*i*) The management can mould, efficiently, effectively to meet new environments and circumstances.
(*j*) Degree of flexibility, reliability and accessibility in functions of management *viz.* planning, coordination, staffing, organisation, motivation, direction and control enlarges.

(*k*) It helps in easing of the burden of the supervisor.

(*l*) Reduced cost of supervision.

(*m*) Coordial relation between supervisor and subordinates.

(*vi*) *Advantages to Capital Investment:*

(*a*) It helps in management of fixed or block capital, working capital earning, and dividends.

The capital can be raised very easily and quickly.

The finance functions can be carried out effectively and efficiently.

(*b*) It helps in reduced investment in machines and equipment by:

(*i*) Increasing production per machine.

(*ii*) Utilising idle hours of machine.

(*iii*) Reduced inventory of waste, in progress and of finished products.

(*iv*) Standardisation and simplification.

(*v*) *Advantages to Marketing Management.* This includes:

(*a*) Better and fine image of the company and thus creating higher watering capital such as goodwill, repute and fame by:

(*i*) Maintaining excellent quality of product.

(*ii*) Quality of all products but cheaper in competition.

(*iii*) Satisfaction of the consumer in psychological field and actual operational field.

(*b*) It helps in introducing now product in market.

(*c*) Company can stand in competition as cost of production per unit of production is less.

(*d*) Marketing staff can be procured at lower initial investment, moreover this staff will be of better quality, and of higher excellence in all fields.

(*e*) Risk carrying cost decreases.

(*f*) Cost of advertising reduces.

(*g*) Market research cost declines.

From Worker's point of view

Under this caption, we include the following:

(*a*) Reduced efforts of the worker.

(*b*) Reduced number of handling.

(*c*) Reduced fatigue and boredom.

(*d*) Acquires process of specialization.

(*e*) It permits working at maximum efficiency.

(*f*) Higher morale and team spirit.

(*g*) Job satisfaction and job pride.

(*h*) Reduced number of accidents.

(*i*) High earnings which helps him:

1. To raise standard of living.
2. To satisfy all his physiological demands more effectively and efficiently.
3. Can maintain his family up-to-date, *e.g.* better education of children, better housing, better food and clothes etc.

From Shareholder's point of view

(*a*) Higher dividends; regularly and certainly in the future.

(*b*) Psychological satisfaction.

(*c*) Reduced speculation in the shares.

From Consumer's point of view

(*a*) Reduced cost per piece.

(*b*) Better and excellent quality.

(*c*) Psychological satisfaction.

From Society point of view

(*a*) Quicker and faster capital formation which leads to higher national income and income per capita, which decides the standard of living of the country's people.

(*b*) It helps in unemployment problems.

(*c*) Better and efficient application of welfare economics as government raises more revenue from the company on account of their higher earnings.

(*d*) National repute and self-dependence and self-reliance spirit is boost up

(*e*) The nation progresses towards prosperity.

(*f*) Stability and security of the nation is achieved.

1.3.3 Problems of PPC

Production planning operational and control problems require two major types of decisions one that relates to the design of the system and the other that relates to the operation and control of the system (that is both long run and short run decisions) the relative balance of the emphasis on such factors as cost, services, reliability of both functional and time performance depends on the basic purposes of the enterprise or institution and on the general nature of goods or service being produced. In general economic enterprises will probably emphasize cost, consistent with quality and delivery commitments.

A classification of problems is as follows:

(A) Long run decision related to the design of production and operation's system:

(*a*) Selection of equipment and process.

(*b*) Production design of items processed.

(*c*) Job design.

(*d*) Location of the system.

(*e*) Facility layout.

(B) Decisions related to the design of operation and control systems:

(*a*) Inventory and production control.

(*b*) Maintenance and reliability of the system.

(*c*) Quality control.

(*d*) Labour control.

(*e*) Cost control and improvement.

The relative importance of these problems in operation's management varies considerably depending on the nature of individual production system. Nevertheless, every system has these problems in some degree. For example, replacement policy may occupy a dominant position in production systems where the capital investment per worker is very large in the steel industry, on the other hand, replacement policy may occupy a minor role in a production

system that is represented by a large labour component or a large material cost component. Part of the area of the operation management involves the sensing of the relative importance of these various components in a given situation.

1.4. FUNCTIONS OF PPC

The highest efficiency in production is obtained by manufacturing the required quantity of product, of the required quality, at the required time by the best and cheapest method. To attend this objective management employs production planning and control, the tool that co-ordinates all manufacturing activities.

The main functions of PPC can be classified in ten categories:

(*i*) **Materials.** Raw materials, as well as standard finished parts and semi-finished products must be available when required to ensure that each production of operation will start on time. Duties include the specification of materials (both with respect to dimensions and quality) quantities and availability; delivery dates, standardization and reduction of variety, procurement and inspection. This function also covers the procurement of semi-finished products from subcontractors.

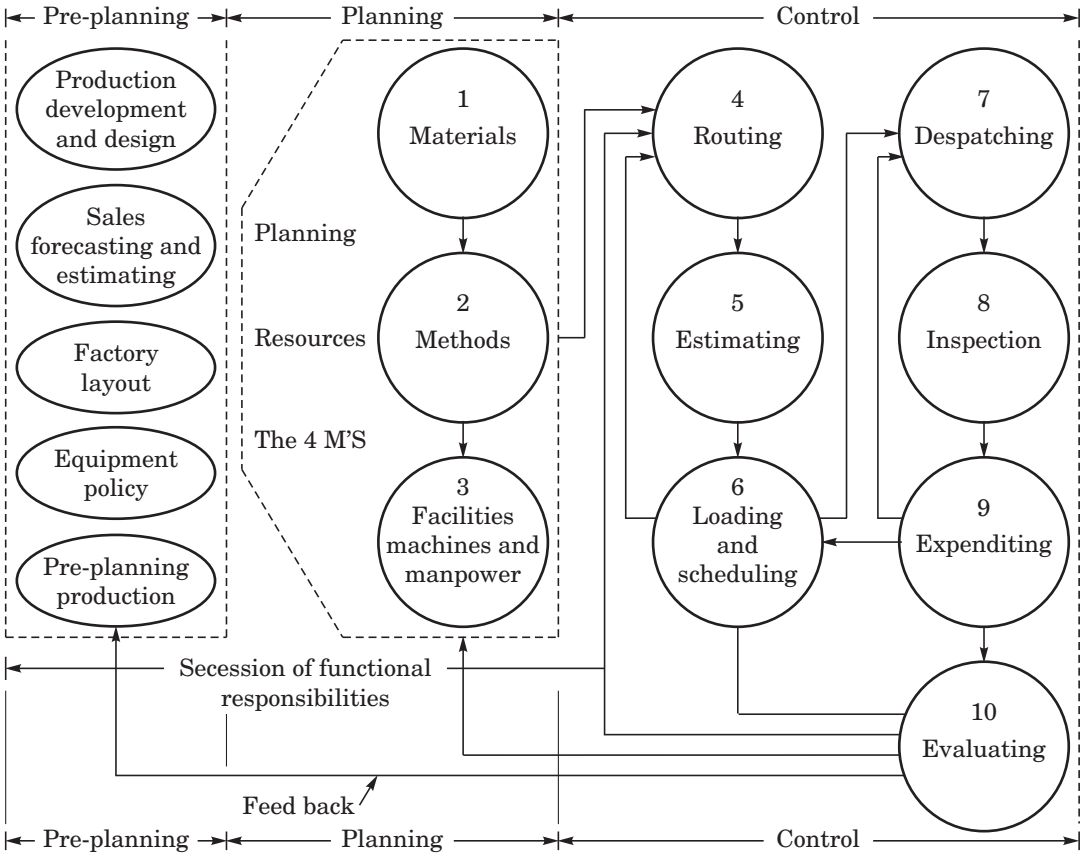

Fig. 1.1. The ten functions of Production Planning and Control Cycle.

(*ii*) **Methods.** (*a*) The purpose of this function is to analyse possible methods of manufacture and to try to define the best method compatible with a given set of circumstances

and facilities. This analysis covers both the general study and selection of production processes (for the manufacture of components or assemblies) and the detailed development and specifications of methods of application.

(*b*) such a study results in determining the sequence of operations and the division of the product in to assemblies and sub-assemblies, modified by the limitations of existing layout and work flow.

(*iii*) **Machines and equipments.** Methods of manufacture have to be related to available production-facilities, coupled a detailed study of equipment replacement policy. Maintenance policy, procedure and schedules are also functions connected with managerial responsibility for equipment, since the whole problem of breakdowns and reserves can be seriously reflected in halts in production tool management, as well as problems both design and economy of jigs and fixtures, constitutes some of the major duties of production planning and control.

(*iv*) **Routing.** Once the overall methods and sequence of operations have been laid down, each stage in production is broken down to define each operation in detail, after which the issue of production orders can be planned. Routing prescribes the flow of work in the plant and is related to considerations of layout of temporary storage locations for raw materials and components and of material handling systems. Routing is fundamental production function on which all subsequent planning is based.

(*v*) **Estimating.** When production orders and detailed operation sheets available with specifications feeds, speeds, and use of auxiliary attachments and methods, the operation times can be worked out. This function involves the extensive use of operation analysis in conjunction with methods and routing as well as work measurement in order to set up performance standards. The human element figures prominently in work measurement because it is sensitive to systems of work rating and wage incentive schemes. Hence it may consequently result in a wide scatter of operation times and in unduly large fluctuations and perhaps instabilities in time schedules.

(*vi*) **Loading and Scheduling.** Machines have to be loaded according to their capability performing the given task and according to their capacity. Machine loading is carried out in conjunction with routing to ensure smooth work flow ; and with estimating, to ensure that the prescribed methods feeds and speeds are best utilised. Scheduling is perhaps the toughest job facing a production manager because it determines the utilisation of equipment and manpower and hence the efficiency of the plant. Scheduling must ensure that operations are properly dovetailed that semi-finished components arrive at their next station in time, that assembly work is not delayed; and that on the other hand the plan is not unnecessarily loaded with physically and financially with work in process, *i.e.* with semi-finished components waiting for their next operation. This calls for a careful analysis of process capacities, so that flow rates along the various production lines can be suitably co-ordinated. In machine loading, appropriate, allowances for set up of machines, process adjustments, and maintenance down-time have to be made, and these allowances form a vital part of the data constantly used by the scheduling function.

(*vii*) **Despatching.** This function is concerned with the executive of the planning function. Despatching is 'the routine of setting productive activities in motion, through release of orders and instruction and in accordance with previously planned times and sequences as embodied in route sheets and loading schedules'. Despatching authorizes the start of the production operations by releasing materials, components, tools, fixtures and instruction sheets to the operator, and ensures that material movement is carried out according to the planned routing sheets and schedules.

(*viii*) **Expediting.** This control tool is the executive arm that keeps a close watch on the progress of the work expediting or 'follow up' or 'progress' as it is some times called, is logical step after despatching. Despatching maintains them and sees them through to their successful completion. This function has to keep close liaison with scheduling, in order to provide efficient feed-back and prompt review of targets and schedules.

(*ix*) **Inspection.** Another major control function is that of inspection. Although the control of quality is often detached from the production planning and control department, its findings and criticisms are of supreme importance both in the execution of current plans and in the planning stage of future undertakings. When the limitations of processes, methods and manpower are known, then these limitations can form a base for future investigations in evaluating, with the view to improving production methods, or indicating the cost implications of quality at the design stage.

(*x*) **Evaluating.** Perhaps the most neglected function, but on an essential link between control and future planning, is that of evaluating. The executive tasks of despatching and expediting are concerned with the immediate issues of production and with measures that will as certain the fulfilment of set targets. Valuable information is gathered in this process, but the feedback mechanism is rather limited in nature and unless provision is made so that all this accumulated information can be properly digested and analysed, valuable data may be irrtrievably lost. Thus here the evaluating function comes in, to provide a feed-back mechanism on a longer term basis so that past experience can be evaluated with the view to improving utilisation of methods and facilities. Many firms consider this function important enough to divorce part of it from production, planning and control land to establish it as a separate department in its own right, in which wider aspects of production management can be studied, using modern tools of operations research. Whatever the scope of evaluating in the production planning and control department, this process is an integral part of the function.

The ten functions were listed above in the order of their operation. As shown in Fig. 1.1, they are related to three stages, preplanning, planning and control.

Preplanning. This covers an analysis of data and outline of basic planning policy based on sales, reports, market research and product development and design on the broad aspects of planning, this stage is connected with problems of equipment policy and replacement, new processes and materials, layout and work flow.

Preplanning function as a production planning and control responsibility is also preoccupied with collection of data on the '4M's, *i.e.* on materials, methods, machines and manpower, mainly with respect to availability, scope and capacity.

Planning. When the task has been specified a thorough analysis of the "4 M's" is first under taken to select the appropriate materials, methods and facilities by means of which ; the work can be accomplished, as already mentioned. This analysis is followed by routing, estimating and scheduling. The more detailed, realistic and precise the planning, the greater conformity to schedules achieved during production and subsequently greater the efficiency of the plant. There are two aspects of planning, a short term one, connected with immediate production programmes, and a long term phase, where plans for the more distant future are considered and shaped. Prominent planning functions are these dealing with standardisation and simplification of products, materials and methods.

Control. This stage is effected by means of despatching, inspection and expediting. Control of inventories, control of scraps, analysis of work in process, and control of transportation are essentially links of this stage. Finally, evaluation takes place to complete the production planning and control cycle.

The control functions have a very important rate in providing the main sources of feedback information to ensure necessary corrective actions. Effective communication systems are prerequisites to efficient control and are, therefore, of great concern to production planning and control.

The ten functions of production plan, and control were related in what might be regarded as a chronological order in the production procedure. It is important to stress, however, that there is a veiy strong connection and interdependance between, production planning and control, and other industrial engineering functions, some of which are briefly described below.

Plant lay-out. Layout not only affects the allocation of machines to perform given task but it may also becomes an important factor at the design stage in selection of production processes. A rigid layout may hamper the integration of additional equipment in a specific production centre either through lack of space of limited mobility of the equipment. This may lead to long lines of transportation which increases the total production costs and the amount of work in process. On the other hand, sequences of operations changes in plant layout must often be undertaken in the light of production planning and control requirements, in order to achieve a satisfactory work flow. Thus, the production planning and control is affected by the restrictions imposed on the system by the layout, and at the same time it may greatly contribute through evaluation to modifications in layouts.

Specification and Standardisation. Production of different components, models or products lead to a demand for different types of materials and methods of fabrication. At the various stages of manufacture, variety may, therefore, occur in materials, bought out parts, manufacture components, minor and major assemblies for finished products as well as in processes methods of manufacture, tools, jigs and fixtures, machines, etc. Simplification and standardisation are functions which aim at finding a limited variety of different types so that the basic requirements are satisfied and the efficiency of the plant is increased. Most aspects of simplification and standardisation are the joint responsibility of several department, *e.g.* the question of limiting the variety of finished products would involve the sales department, production department and the design office, while questions relating to simplification of materials would also include inventory control considerations and perhaps involve the research and development department. Some aspects of simplification and standardisation are major responsibilities of the production planning and control department, such as problems relating to machines and methods.

Time and Motion study. This field is closely allied to efficient utilisation of manpower and scheduling problems. Time and motion study consists of two fields of activity, operation analysis and work measurement.

(*a*) *Operation analysis or method study.* Which as the name suggests, consists of a evaluation, selection and development of an efficient method to perform a given task. Operation analysis is concerned both with problems of limited scope (such as operator's work place layout, an activity study of a gang of operators or correlation of machine, operator activities) and overall studies of the process, in which all aspects of routing, plant, layout and scheduling may play an important role.

(*b*) *Work measurement.* Which is concerned with stabilising standard times for the various operations in the process for the estimating function in production planning. As already mentioned no scheduling can ever be attempted before some data on performance times becomes available.

From the foregoing remarks it should be appreciated that time and motion study is employed both at the planning and control stages. Development of methods and information regarding the measurement of processing times can be obtained in two ways.

(*a*) **By synthesis** based on past experience of similar circumstances, where the same processes are employed. Synthesis is an important tool at the planning stage.

(*b*) **By analysis** of an existing production method and measurement of operation times when the process is already in action. This obviously belongs to the control stage, and information gathered in this way provides a basis for replanning and readjusting of production schedules, when these are proved to be unrealistic and for data required for future synthesis.

Although these two distinct functions of time and motion study are employed at different stages of production planning and control and for different processes; they share the same philosophy, the same approach, the same techniques, and even if they can be divorced in time they are essentially integral parts of the same field.

The importance of materials availability at the various stages of production necessitates a mechanism of inventory control and stores organisation. Inventories are a financial burden on the plant and management of stores may be very costly. Inventory control is sometimes a very complex function as its policies are not dictated by internal needs and considerations along out by external factors governing the purchasing of materials, such as vendor's offers and terms, market availability. Factor may influence both quantity and delivery dates of materials and components and have to be taken into account by any inventory control mechanism.

1.5. WHY PPC?

Many of the problems of production interact with each other. For example, job design may interact with the material handling system used, the design of the things being processed, the equipment or process being used, and the overall facility layout. An optimal inventory policy to follow is partially dependent on the means by which production levels are controlled. The best process (in instances where alternatives exist) may depend on whether idle labour or equipment is available. If we were to study inventory problems in isolation, ignoring the effects of changes in production level, we would develop a sub-optimal solution to the problem, because the solution that minimizes inventory cost might result in very high cost associated with production fluctuations. The policy we wish to determine is one that would minimize all cost affected. Therefore, the broader the point of view taken in attempting to solve the problem, the less likely it is that factors will be ignored which bear significantly on the final result. This, then is the guide to determine the limit of the production system under study.

Achieving this systems concept in practical application is difficult for two important reasons ; first the present day models fall short of this ideal and second it requires crossing established functional line of authority, with in the organisations. This latter factor is of great practical significance because of the human relation problems involved in gaining support for proposals that may tear down personal empires or threaten individuals with in organisation structure.

Case Study of PPC Implementation: Tools and Tooling Division of a Job order Concern

In any job order manufacturing concern every product division has its own engineering section. As soon as the design of any machine is finalised the Drawing Office (DO) starts releasing the drawings to Production Planning, Industrial engineering division (IE), Tool Engineers shop etc. The Tool Engineers study the component drawing and in consultation

with I.E. prepares are tool list tentatively and send the same to the chief Draughtsman or convenor of Tool Committee Meeting (TCM) and Tool and Tooling D.O. for discussions in Tool committee meeting. In the tools Committee Meeting representative from Production Planning (Product), Tool Engineer, Industrial Engineering, Tools and (Product) Tool and Tooling D.O. are being called for discussion special tools required are finalised and probable date of completion (PDC) for design and manufacturing of tools are also fixed. The concern Tool Engineers are informed through minutes of Tool Committee Meeting to raise necessary tool orders.

After receipt of tool and pattern (T&P) requisition in Tool and Tooling D.O., design work starts. The minutes are also received in Planning and necessary entries are made in tool commitment folder and register PDCS are committed in the meeting considering the following points:

1. Capacity of shop.
2. Nature of work involved.
3. Type of Tool, *i.e.,* light, medium or heavy.
4. Manufacturing order delivery date (Urgency required).

Tool orders are kept in awaiting drawing file till the design is received in planning. As soon as the design is received the drawing is scrutinised in respect of material availability, alterations involved, any off loading required, any bought out material like beazing etc. involved. It is also assessed in planning section whether the job can be completed within the promised time. Seeing all the details the tool order along with tool drawing is sent to process section for detailed processing, after indicating the PDC in the tool order.

The detailed process along with the material requisition and EPC is prepared in process section and sent back to planning section job cards are typed with a work order number alloted for shop reference. Every tool is alloted to a supervisor in the fitting/assembly (F/A). Then the following papers are sent to production control section for further necessary action:

1. 3 sets of tool drawings.
2. 2 sets of process sheet.
3. Job cards for each operation.

Material requisition is sent to stores directly from planning. After receipt of material in production control items are progressed in different sections, as per process sheet and finally to F/A for assembling the tools.

After the assembly is over the concerned supervisor of F/A prepares the factory receipt (P/R) and offers the job to inspection. After the jobs passed by inspection all papers are closed in F/A and control and F/R number is alloted in planning and job is shipped to the tool engineers through the shipper.

An addition to the above function Production Planning has got responsibility of preparing weekly and monthly process reports. Material budgets manpower planning, material procurement action are also initiated by production planning, advance off loading of tools to ancillary and out side party is also some times initiated by planning and the demands of product divisions and fulfilled. The schematic production planning system is described below.

<table>
<tr><th colspan="3">PRODUCTION PLANNING AND CONTROL</th></tr>
<tr><th>Technique of Planning</th><th>Analysis of Products</th><th>Technique of Control</th></tr>
<tr><td>Note: kind of material
Note: grade or quality of material

Determine quantities requird for order

As certain availability of Materials
Take reservation of available stock
Requisition material not in stock
Prepare material move Orders</td><td>Material
Unit material multiplied by Quantities on order.</td><td>Watch delivery of purchased material
Release of material orders at proper time.</td></tr>
<tr><td>Use machine analysis to plan best method of processing plan tools and fixtures required. Determine time allowances plan best sequence of operation. Schedule machine loads, prepare work orders and time cards for each process on each lot.</td><td>MACHINE PROCESS
Unit processes multiplied by number of pieces in each lot</td><td>Release tool and fixture orders as required. Observe actual operation times. Check actual with scheduled loading. Release work orders and time cards at scheduled times.</td></tr>
<tr><td>Specify inspection standards plan assemblies and Sub-assemblies prepare inspection orders schedule due dates for each process on each lot and assembly schedule due date for each order.</td><td>PRODUCT
(Work in Process)
Lots of single parts. Sub-Assemblies Assemblies Final Inspection</td><td>Check quantities passing inspection. Put replacement in hand as required. Release inspection orders when jobs are ready.
Observe and record completion of jobs. Check actual with scheduled progress of each lot. Observe that scheduled dates are being kept.</td></tr>
<tr><td colspan="3">Analyze order for its minutest Parts or Components.</td></tr>
<tr><td colspan="3">For each part determine</td></tr>
<tr><th>AS TO MATERIAL</th><th>PREPARE</th><th>AS TO OPERATIONS</th></tr>
<tr><td>1. Quantity required
2. Quantity or grade
3. If available in stores
4. If so make reservation of cards.
5. If not time required for delivery.
6. Post (5) to route sheet item (2)</td><td>Stores issue and move orders job orders time cards
Inspection orders.</td><td>1. What Operation required
2. Class of machine for each
3. Preparation and operation time.
4. Tools and Fixtures required.
5. Sequence, if technically essential.
6. Embody data in operation sheet.</td></tr>
</table>

OPERATION SHEET (One for each part)	**ROUTE SHEET (One for each sheet)**
1. Operation on the party 2. Material allowances for the part. 3. Tools and Fixtures for each operation. 4. Time allowance for each operation Note. Operation sheets form standard instructions Good till supersealed.	1. Number of pieces in lot. 2. Date of delivery of material. 3. Operation and machine to be used. 4. Sequence of operations. 5. Tool time for lot, each operation. 6. Post (5) to machine tool chart. 7. Grinder machine data for each operation and post to schedule. Note. In large plants each department may have separate Rout sheets.
MACHINE LOAD CHART (One for each machine)	**PRODUCTION SCHEDULE OR PROGRESS BOARD (Divisions by hours, days, weeks or months)**
1. Past total time of lot from route sheet (5) 2. Determine available data to begin job. 3. Observe date of completion. 4. Post (2) and (3) to route sheet.	1. Post dates of lots from route sheets. 2. Check off lots as completed. 3. Notify parties responsible for all delays. 4. Post and keep track of all replacements. 5. Forward papers to despatch day by day.
DESPATCHING RACKS	**DESPATCHING FILES**
(Triple compartment for each machine) Holds current next and reserve of job orders for each machine.	(Division by orders numbers and operations) All orders and papers pertaining to each lot filed for quick handling when time for release arrives. *Stores issue orders *move orders *Job ordres *Blueprints *Operation Sheets *Time cards *Inspection

REVIEW QUESTIONS

1.1. Define production. Distinguish between production and production system.

1.2. State production problem areas.

1.3. Production Planning is one of the essential requirements of factory organisation. Discuss this statement and describe the point that you would take into account in planning the production of Engineering industry.

1.4. "Production Planning department is the nerve centre of any workshop". Discuss.

1.5. What do you understand by Production Planning and Control?

1.6. Define the Production Planning and Control and explain the current view.

1.7. What are the aims and objectives of Production Planning and Control.

1.8. Discuss carefully the need for PPC under the present circumstances of India.

1.9. What are the functions and importance of PPC?

1.10. Does India need PPC for her developing economy?

1.11. What is the organisation of PPC?

1.12. What is production control department? Who heads the department?

Choose the correct answer

1.13. Equipment is the policy function of production planning control and comes under one of the following stages.

(*a*) Preplanning (*b*) Planning

(*c*) Control (*d*) After control.

1.14. Out of the following functions which function of production planning and control does not come in planning stage.

(*a*) Material (*b*) Methods

(*c*) Machines and Man Power (*d*) Estimating.

1.15. Which one of the following is odd M's used in Production Planning and Control:

(*a*) Material (*b*) Memo

(c) Machines (*d*) Man power.